Laboratory Analysis for Arsenic in Drinking Water Samples

Barbara Francis, USEPA, ORD, NRMRL, WSWRD, TTEB, Cincinnati OH

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Abstract

The U.S. Environmental Protection Agency (USEPA) has established maximum contaminant levels (MCLs), for many inorganic contaminants found in drinking water, to protect the health of consumers. Some of these chemicals occur naturally in source waters while some are the result of human contamination. Arsenic in water has been a recent regulatory focus of the USEPA. Relatively new health effects research prompted the USEPA to reduce the arsenic standard from 0.050 mg/L to 0.010 mg/L. Public water systems will have until February 2006 to be in compliance with the new rule.

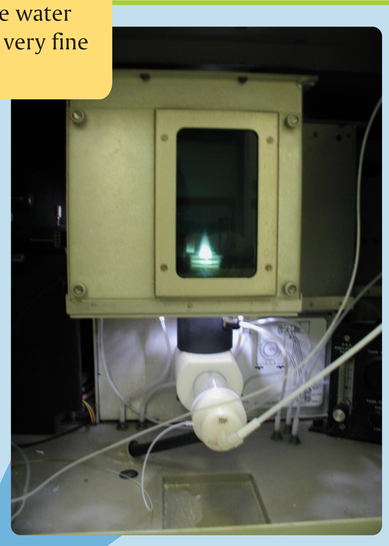
Changing from one water treatment process to another can alter the chemistry of the output water. These changes may cause leaching of built-up deposits, which may contain trace contaminants such as arsenic, within the drinking water distribution pipes thereby creating additional problems. Studies are currently being conducted to determine whether arsenic will leach from distribution system solids. Also, ongoing studies, lasting 3 months at a time, are conducted at the EPA laboratories using a small-scale water treatment plant to determine the effects of oxidation-reduction potential on the corrosion of copper, lead, iron, and brass piping.

These studies require analytical support to completely characterize the water chemistry during these testing phases. One analytical technique determines the concentration of 21 to 28 different elements, simultaneously in samples of water. This analysis is conducted on an inductively coupled argon plasma atomic emission spectrometer (ICAP-AES). The analytical technique determines these elements in the 0.0001 to 100 mg/L range. This information is employed to determine relationships and interdependency of the major background components and the elements of interest; arsenic, copper, lead and iron.

These measurements are charted over the three-month study period and
reveal changes in the amounts of chemicals found in the water during that time. The results of this testing reveal the effects of the various changes and provide guidance for municipal water treatment plants throughout the United States.

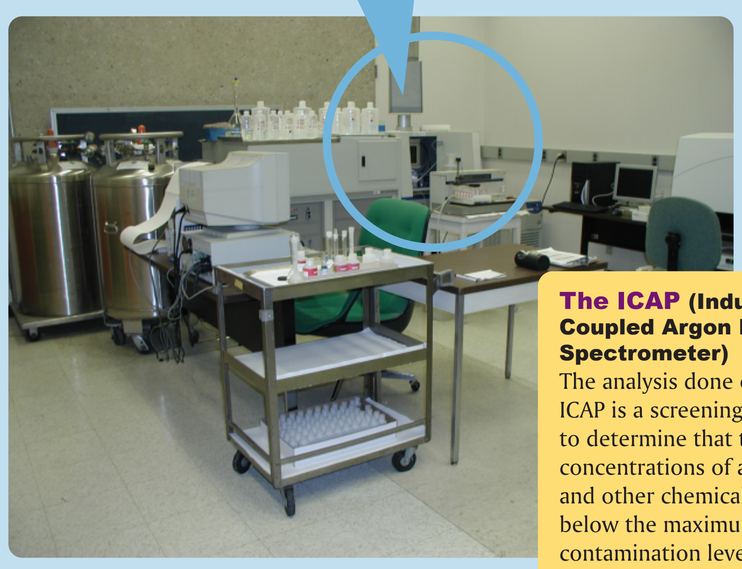
KEY WORDS:

Arsenic
Drinking Water
Analysis
Instrumentation
Treatment Studies

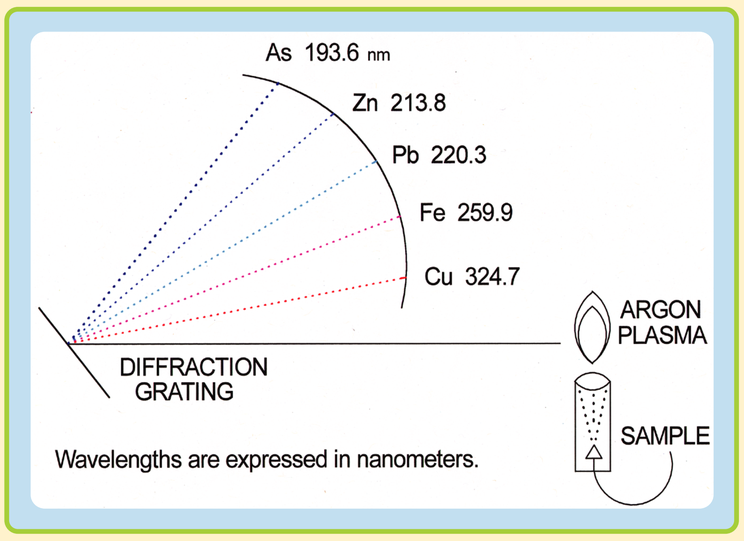


The Auto Plasma
The argon plasma (flame) which turns the water samples into a very fine aerosol mist.

The Auto Analyzer
The prepared water samples are pumped, into the ICAP, from the test tubes.

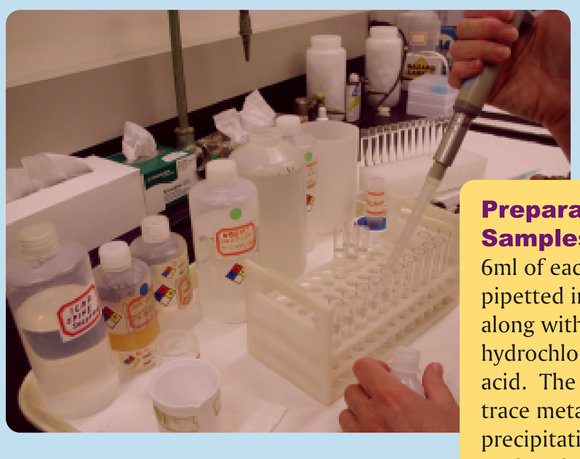


The ICAP (Inductively Coupled Argon Plasma Spectrometer)
The analysis done on the ICAP is a screening process to determine that the concentrations of arsenic and other chemicals are below the maximum contamination levels (MCLs) established by the EPA.



LIGHTWAVES FROM VARIOUS ELEMENTS BEING MEASURED INSIDE THE ICAP

Inside the ICAP-AES the water samples are converted to a fine aerosol and then introduced into the argon plasma operating at a temperature of 5,000 C°. The plasma heats the aerosol to reduce the inorganic components to their elemental composition, and then thermally excites the electrons of the elements present in the sample. The electrons return to their ground or normal state by emitting light characteristic of the element. Each element has a set of distinct wavelengths or “colors”. This light is focused on a grating or prism to separate these wavelengths. This light is then directed towards detectors located to receive light specific for each element. The light measurements are then converted to concentration.



Preparation of Water Samples
6ml of each water sample is pipetted into a testtube, along with a 3ml of hydrochloric acid and nitric acid. The acids keep the trace metal particles from precipitating, while being analyzed.

Arsenic Rule Implementation Research Program

Background

On October 31, 2001 EPA announced that the final standard for arsenic in drinking water of ten parts per billion (10 ppb) would become effective on February 22, 2002 without any further action by EPA. This means that the standard will be implemented as specified in the January 22, 2001 final rule, and the date by which systems must comply with the new standard is January 23, 2006. As part of that announcement, the Administrator pledged to provide $20 million over the next two years (2002/2003) for the research and development of more cost-effective technologies as well as technical assistance and training to operators of small systems to reduce their compliance costs.

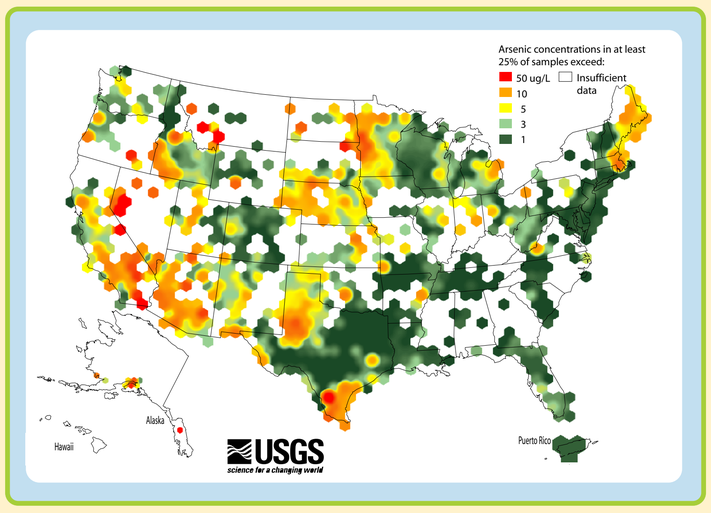
The Administrator's Press Release

EPA's Office of Research and Development is spearheading the research program. The purpose of the effort is to provide information to fill-in research gaps that exist for a number of technologies or compliance approaches and provide this information to utilities, engineering firms, regulatory officials and others.

In Fiscal Year 2003, Congress appropriated $5,000,000 for Small System Arsenic Removal research. The conferees strongly encouraged EPA to utilize a significant portion of the funding to carry out demonstrations of implementation of low-cost treatment technology and directed the Agency to report to the Committees on Appropriations by August 15, 2003, on its plans to carry out such demonstrations.

The Arsenic Treatment Technology Demonstrations will be conducted at the following sites:

Site	Technology to be Demonstrated
Rimrock, AZ	AdEdge Iron Media
Valley Vista, AZ	Kinetico Activated Alumina
City of Fruitland Fruitland, ID	Kinetico Ion Exchnage
Queen Anne's County Stevensville, MD	Severn Trent Iron Media
Brown City Brown City, MI	Severn Trent Iron Media
Town of Climax Climax, MI	Kinetico Oxidation / Co-Precipitation / Filtration
City of Lidgerwood Lidgerwood, ND	Kinetico Modified Treatment
Holiday Acres Water & Wastewater Service Allenstown, NH	ADI Iron Adsorption / Regeneration
Rollinsford Water & Sewer District Rollinsford, NH	AdEdge Iron Media
Desert Sands Mutual Domestic Water Consumers Association, Inc. Anthony, NM	Severn Trent Iron Media
Nambe Pueblo, NM	AdEdge Iron Media
South Truckee Meadows GID Washoe County Water Resources Reno, NV	US Filter Iron Media



Arsenic concentrations found in at least 25% of ground water samples in each county.